Exercise walk-through

Equilibrium of a rigid body ▪ 3.2

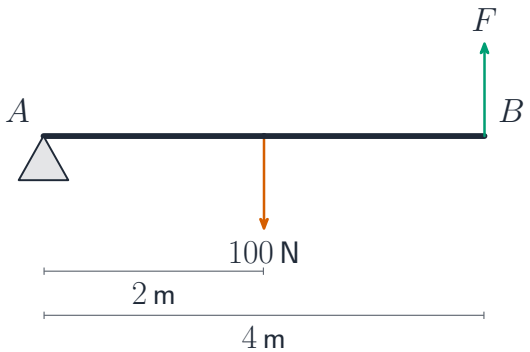
eXercise

You must be able to

- take moments about a point (force $\times$ perpendicular distance)
- apply the two equilibrium conditions (forces and moments both balance)
- decide whether a body topples or slides first

Method — Taking moments

Uniform beam AB**, length** 4 **m, weight** 100 **N, pivot at** A**, force** F **at** B**:** moments about $A \rightarrow F \times 4 = 100 \times 2 \Rightarrow F = 50$ N.



A beam on a pivot with a weight at the centre balanced by a force at the end

Practice 2.1 ▪ 2 marks

A force of 20 N acts 3 m from a pivot, at right angles. Find its moment.

Solution 2.1

Method: Taking moments

Worked steps

moment $= 20 \times 3 = 60$ N m (M1) (A1).

Practice 2.2 ▪ 2 marks

State the two conditions for a rigid body to be in equilibrium.

Solution 2.2

Worked steps

the resultant force is zero B1; the resultant moment about any point is zero B1.

Exam-style 3.1 ▪ 1 mark

The moment of a force about a point is force multiplied by:

A time

B the perpendicular distance

C mass

D velocity

Solution 3.1

Method: Taking moments

A time

B the perpendicular distance ✓

C mass

D velocity

Worked steps

B. Moment = force × perpendicular distance.

Exam-style 3.2 ▪ 4 marks

A uniform ladder AB of weight 200 N and length 6 m rests with A on rough ground and B against a smooth vertical wall, at 60° to the horizontal.

(a) By taking moments about A, find the reaction at the wall.

(b) Hence find the friction force at the ground.

Solution 3.2

Method: Taking moments

Worked steps

(a) wall reaction S is horizontal at B; weight 200 N acts at the midpoint (3 m along). Moments about A: $S \times 6\sin 60^\circ = 200 \times 3\cos 60^\circ$ M1 M1; $S \times 5.196 = 300 \Rightarrow S = 57.7$ N M1 A1.

(b) horizontal equilibrium: friction $= S = 57.7$ N M1 A1.

Exam-style 3.3 ▪ 4 marks

A uniform rod AB of length 2 m and weight 40 N rests horizontally on supports at A and at C, where C is 1.5 m from A. Find the reaction at each support.

Solution 3.3

Method: Taking moments

Worked steps

moments about A: $R_C \times 1.5 = 40 \times 1 \Rightarrow R_C = 26.7$ N M1 A1; vertical: $R_A + R_C = 40 \Rightarrow R_A = 13.3$ N M1 A1.